Novel Techniques for Background / Foreground Rejection in Particle Instruments

Completed Technology Project (2012 - 2013)

Project Introduction

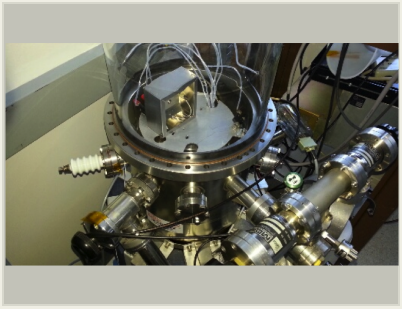
The Novel Techniques for Background / Foreground Rejection in Particle Instruments project addresses the need for signal contamination and background signal suppression for particle instrumentation (e.g. plasma instruments and mass spectrometers), a typical problem for instruments in various geomagnetic (e.g. radiations belts and strong UV illumination) and planetary environments (e.g. Jupiter and Saturn). This research will design and implement a background/foreground rejection technology using a simple thin foil and fast coincidence, with wide applicability across scientific disciplines.

Particle instruments in general such as mass spectrometers and plasma analyzers face two common problems that degrade their performance: (a) penetrating radiation through the walls of the instruments resulting in higher noise levels due to increased background signal and (b) undesirable foreground signal (e.g. ions and UV) through the aperture which degrades the useful signal. Both have the effect of reducing the useful S/N in an instrument and therefore performance. Those issues become more severe in certain environments such as the radiation belts but also in FOVs facing the solar geo – coronal light contamination. Typical mitigation techniques for background include increasing the walls of the instruments – with a heavy impact on mass, which is often impractical – or increasing thresholds in suppression. Although the use of foils and coincidence timing in plasma instrumentation is common, the foil and coincidence technique we propose has never been implemented for background/foreground suppression in this way. The proposed technique will solve this problem for future instruments in high radiation environments.

Anticipated Benefits

Reducing contamination due to side-penetrating electrons is especially important for missions spending a fraction of or all of each orbit within the Earth's radiation belts. For example, for Van Allen Probes the main sources of background contamination were identified as side-penetrating electrons and possible solar energetic protons (Dan Baker, “An Overview of Heliophysics Exploration”). The finished product will reject negative ions, side penetrating electrons, and UV photon signals which otherwise become a source of noise. Not only does this rejection method increase the S/N of the measurement but, in reducing the total noise, the noise floor is lowered and the dynamic range increased.

This work is timely because CubeSat micropropulsion systems are currently under development (at companies such as Stellar Exploration), generating interest in CubeSat missions to MEO in the near future. MEO CubeSats are an ideal platform for low cost access to the magnetospheric source region for in situ measurement of electron seed populations for various geomagnetic processes such as pulsating aurora. Combined with data provided by ground instrumentation, including the CARISMA magnetometer chain and the THEMIS



Background / Foreground Rejection Setup

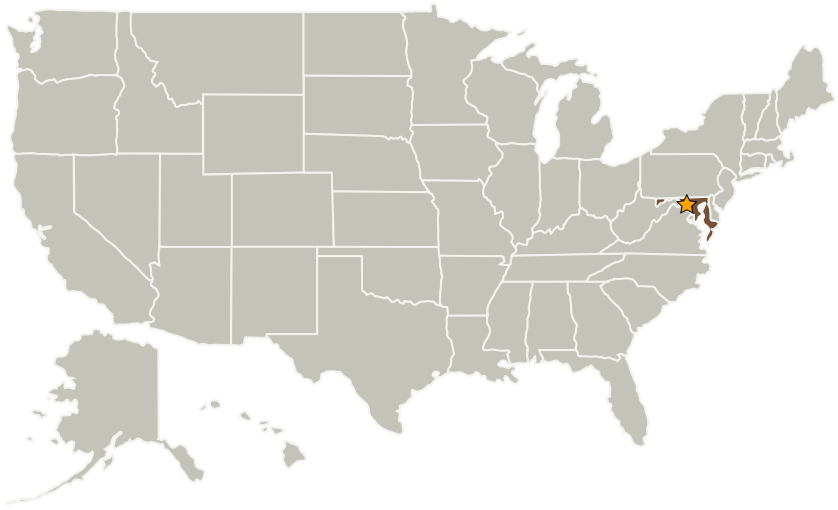
Table of Contents

Novel Techniques for Background / Foreground Rejection in Particle Instruments

Completed Technology Project (2012 - 2013)

all-sky imager array, one or several CubeSats instrumented with solid state telescopes in MEO will result in high science payoff. A suite of such CubeSats is a feasible concept for the next NASA SMEX and would be highly complimentary to RBSP.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Maryland

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Manager:

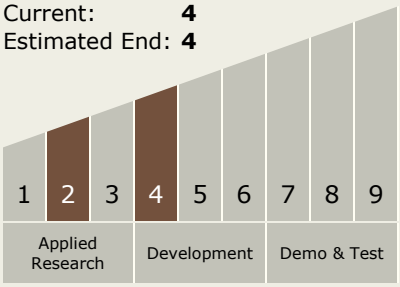
Nikolaos Paschalidis

Principal Investigator:

Sarah L Jones

Technology Maturity (TRL)

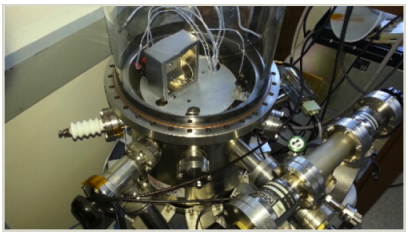
Start: **2**
Current: **4**
Estimated End: **4**



Novel Techniques for Background / Foreground Rejection in Particle Instruments

Completed Technology Project (2012 - 2013)

Images



Background / Foreground Rejection Setup
Background / Foreground Rejection Setup
(https://techport.nasa.gov/image/4101)

Project Website:

http://sciences.gsfc.nasa.gov/sed/

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.3 In-Situ Instruments and Sensors
    - TX08.3.1 Field and Particle Detectors